

What is claimed is:

- 1           1. An angular velocity sensor comprising:
  - 2                 a sensor element including a vibrating part and a detector part for
  - 3                 detecting an angular velocity;
  - 4                 a drive unit including a driver circuit and a monitor circuit, wherein said
  - 5                 driver circuit supplies a driving signal to the vibrating part of said sensor element
  - 6                 and wherein said monitor circuit receives a monitor signal outputted from said
  - 7                 sensor element;
  - 8                 a detection unit including a pair of charging amplifiers or current
  - 9                 amplifiers, a differential amplifier and a synchronous demodulator, wherein said pair
  - 10                of charging amplifiers or current amplifiers receive outputs from the detector part of
  - 11                said sensor element, said differential amplifier amplifies a difference in outputs from
  - 12                said pair of charging amplifiers or current amplifiers and wherein said synchronous
  - 13                demodulator detects an output from said differential amplifier in synchronous with the
  - 14                driving signal from said drive unit and outputs an angular velocity signal; and
  - 15                a self diagnosis unit for outputting a diagnosis signal to detect an
  - 16                abnormality of said sensor element by coupling a signal synchronized with said
  - 17                driving signal to a circuit, said circuit having an output coupled to said synchronous
  - 18                demodulator.

- 1           2. An angular velocity sensor comprising:
  - 2                 a sensor element including a vibrating part and a detector part for
  - 3                 detecting an angular velocity;

4                   a drive unit including a driver circuit and a monitor circuit, wherein said  
5    driver circuit supplies a driving signal to the vibrating part of said sensor element  
6    and wherein said monitor circuit receives a monitor signal outputted from said  
7    sensor element;

8                   a detection unit including a pair of charging amplifiers or current  
9    amplifiers and a synchronous demodulator, wherein said pair of charging amplifiers  
10   or current amplifiers receive outputs from the detector part of said sensor element  
11   and wherein said synchronous demodulator sample-holds an output from said pair of  
12   charging amplifiers or current amplifiers in synchronous with the driving signal from  
13   said drive unit and outputs an angular velocity signal; and

14                  a self diagnosis unit for outputting a diagnosis signal to detect an  
15    abnormality of said sensor element by coupling a signal synchronized with said  
16    driving signal to a circuit, said circuit having an output coupled to said synchronous  
17    demodulator.

1                  3. An angular velocity sensor comprising:

2                  a sensor element including a vibrating part and a detector part for  
3    detecting an angular velocity;

4                  a drive unit including a driver circuit and a monitor circuit, wherein said  
5    driver circuit supplies a driving signal to the vibrating part of said sensor element  
6    and wherein said monitor circuit receives a monitor signal outputted from said  
7    sensor element;

8                  a detection unit including a pair of current amplifiers, a differential  
9    amplifier, a phase shifter and a synchronous detector, wherein said pair of current  
10   amplifiers receive outputs from the detector part of said sensor element, said

11 differential amplifier amplifies a difference in outputs from said pair of current  
12 amplifiers, said phase shifter shifts the phase of an output of said differential amplifier  
13 by 90 degrees and wherein said synchronous detector detects an output from said  
14 phase shifter in synchronous with the driving signal from said drive unit and outputs  
15 an angular velocity signal; and

16               a self diagnosis unit for outputting a diagnosis signal to detect an  
17 abnormality of said sensor element by coupling a signal synchronized with said  
18 driving signal to a circuit, said circuit having an output coupled to said synchronous  
19 detector.

1               4. An angular velocity sensor as recited in claim 1, wherein said signal  
2 synchronized with said driving signal is coupled to an input terminal of said pair of  
3 charging amplifiers or current amplifiers.

1               5. An angular velocity sensor as recited in claim 1, wherein said signal  
2 synchronized with said driving signal is an output from said monitor circuit.

1               6. An angular velocity sensor as recited in claim 1, wherein said self  
2 diagnosis unit comprises an attenuator and an injector, wherein said attenuator  
3 attenuates said signal synchronized with said driving signal and said injector injects  
4 the signal outputted from said attenuator to a circuit, said circuit having an output  
5 coupled to said synchronous demodulator.

1               7. An angular velocity sensor comprising:

2               a sensor element including a driver part and a detector part for detecting  
3 an angular velocity;

4                   a driver circuit for supplying a driving signal to the driver part of said  
5 sensor element, wherein a monitor signal is output from said sensor element and  
6 coupled to said driver circuit;

7                   a detection unit including a charging amplifier and a synchronous  
8 detector, wherein an output from the detector part of said sensor element is  
9 applied to said charging amplifier, and wherein said synchronous detector receives  
10 both a signal synchronized with said driving signal and an output of said charging  
11 amplifier, said detection unit outputting an angular velocity signal; and

12                  a self diagnosis unit for detecting an abnormality of said sensor  
13 element and outputting a self diagnosis signal by coupling said signal  
14 synchronized with said driving signal to an input of said synchronous detector,

15                  wherein said self diagnosis unit comprises:

16                  an attenuator for attenuating the signal synchronized with said driving  
17 signal and

18                  a capacitor for injecting the signal synchronized with said driving signal  
19 from said attenuator to a circuit, said circuit having an output coupled to said  
20 synchronous detector.

1                  8. An angular velocity sensor as recited in claim 6, wherein said injector  
2 comprises a capacitor.

1                  9. An angular velocity sensor comprising:

2                  a sensor element including a driver part and a detector part for detecting  
3 an angular velocity;

4                   a driver circuit for supplying a driving signal to the driver part of said  
5 sensor element, wherein a monitor signal is output from said sensor element and  
6 coupled to said driver circuit;

7                   a detection unit including a charging amplifier and a synchronous  
8 detector, wherein an output from the detector part of said sensor element is  
9 applied to said charging amplifier, and wherein said synchronous detector receives  
10 both a signal synchronized with said driving signal and an output of said charging  
11 amplifier, said detection unit outputting an angular velocity signal; and

12                  a self diagnosis unit for detecting an abnormality of said sensor  
13 element and outputting a self diagnosis signal by coupling said signal  
14 synchronized with said driving signal to an input of said synchronous detector,

15                  wherein said self diagnosis unit comprises:

16                  an attenuator for attenuating the signal synchronized with said driving  
17 signal and

18                  a resistor for injecting the signal synchronized with said driving signal  
19 from said attenuator to a circuit, said circuit having an output coupled to said  
20 synchronous detector.

1                  10. An angular velocity sensor as recited in claim 6, wherein said  
2 injector comprises a resistor.

1                  11. An angular velocity sensor as recited in claim 6, wherein said  
2 attenuator includes a ladder network resistor capable of digitally adjusting an  
3 amplitude and/or phase of an input signal.

1                   12. An angular velocity sensor as recited in claim 1, further including a  
2                   changing unit for changing said self diagnosis unit to either a working state or a non-  
3                   working state.

1                   13. An angular velocity sensor as recited in claim 12, wherein said  
2                   changing unit is a switch for connecting or disconnecting, in accordance with an  
3                   external handling, said signal synchronized with said driving signal to a circuit, said  
4                   circuit having an output coupled to said synchronous demodulator.

1                   14. An angular velocity sensor as recited in claim 12, wherein said  
2                   changing unit comprises a timer circuit for connecting or disconnecting for a given  
3                   time, in accordance with an external handling, said signal synchronized with said  
4                   driving signal to a circuit, said circuit having an output coupled to said synchronous  
5                   demodulator.

1                   15. An angular velocity sensor as recited in claim 2, further including a  
2                   judge unit for continuously judging an abnormality of said sensor element by  
3                   detecting an output signal level of said detection unit during a non-working state of  
4                   said self diagnosis unit.

1                   16. An angular velocity sensor as recited in claim 15, wherein said self  
2                   diagnosis unit comprises an attenuator for attenuating said signal synchronized with  
3                   said driving signal, and an injector for injecting a signal from said attenuator to a  
4                   circuit, said circuit having an output coupled to said synchronous demodulator,  
5                   wherein said changing unit is disposed between said attenuator and said injector.

1                   17. An angular velocity sensor as recited in claim 15, wherein said  
2                   changing unit is a switch for connecting or disconnecting, in accordance with an

3 external handling, said signal synchronized with said driving signal to a circuit, said  
4 circuit having an output coupled to said synchronous demodulator.

1               18. An angular velocity sensor as recited in claim 15, wherein said  
2 changing unit comprises a timer circuit for connecting or disconnecting for a given  
3 time, in accordance with an external handling, said signal synchronized with said  
4 driving signal to a circuit, said circuit having an output coupled to said synchronous  
5 demodulator.

1               19. An angular velocity sensor as recited in claim 1, wherein said  
2 sensor element comprises vibrators composed of at least one of crystal, silicon, the  
3 combination of silicon and piezoelectric film and piezoelectric ceramic material.

1               20. An angular velocity sensor comprising:

2               a sensor element including a vibrating part and a detector part for  
3 detecting an angular velocity;

4               a drive unit including a driver circuit and a monitor circuit, wherein said  
5 driver circuit supplies a driving signal to the vibrating part of said sensor element  
6 and said monitor circuit receives a monitor signal outputted from said sensor  
7 element;

8               a detection unit including a pair of charging amplifiers or current  
9 amplifiers, a differential amplifier and a synchronous demodulator, wherein said pair  
10 of charging amplifiers or current amplifiers receive outputs from the detector part of  
11 said sensor element, said differential amplifier amplifies a difference in outputs from  
12 said pair of charging amplifiers or current amplifiers and wherein said synchronous  
13 demodulator detects an output from said differential amplifier in synchronous with the  
14 driving signal from said drive means and outputs an angular velocity signal; and

15                   an adjusting unit for adjusting a signal from said detector part by  
16                   coupling a signal synchronized with said driving signal to a circuit, said circuit having  
17                   an output coupled to said synchronous demodulator, wherein said adjusting unit  
18                   comprises an adjustor for varying said signal synchronized with said driving signal  
19                   and an injector for injecting an output signal from said adjustor to a circuit, said circuit  
20                   having an output coupled to said synchronous demodulator.

1                   21. An angular velocity sensor as recited in claim 20, wherein said  
2                   injector comprises a capacitor.

1                   22. An angular velocity sensor as recited in claim 20, wherein said  
2                   injector comprises a resistor.

1                   23. An angular velocity sensor as recited in claim 20, wherein said  
2                   adjustor includes a ladder network resistor capable of digitally adjusting an amplitude  
3                   or phase of an input signal.

1                   24. An angular velocity sensor as recited in claim 20, wherein said  
2                   adjustor is capable of adjusting an offset of an output of said detection unit by  
3                   adjusting an attenuation amount of the adjustor.

1                   25. An angular velocity sensor as recited in claim 20, wherein said  
2                   adjustor or injector includes a temperature sensitive element for compensating for  
3                   temperature dependence of the signal synchronized with said driving signal.

1                   26. An angular velocity sensor as recited in claim 20, further including a  
2                   compensating unit for electrically compensating for an electrostatic coupling signal  
3                   generated in an area around the vibrating part and detection part of said sensor  
4                   element, by using a quasi-driving signal.

1                   27. An angular velocity sensor as recited in claim 20, further including  
2 terminals to monitor the driving signal from said driver circuit and an output signal  
3 from the detection part of said sensor element for adjusting.

1                   28. An angular velocity sensor as recited in claim 26, further including a  
2 stop unit for stopping the driving of said sensor element.

1                   29. An angular velocity sensor comprising:

2                   a sensor element including a vibrating part and a detector part for  
3 detecting an angular velocity;

4                   a driver circuit supplying a driving signal to the vibrating part of said  
5 sensor element;

6                   a monitor circuit receiving a monitor signal outputted from said sensor  
7 element;

8                   a drive unit for generating stable self vibration in the vibrating part of  
9 said sensor element;

10                  a control unit for stopping said self vibration;

11                  a signal generator for applying an adjusting signal to the vibrating part  
12 of said sensor element during a working state of said control unit;

13                  a pair of charging amplifiers or current amplifiers receiving an output  
14 from said detection part;

15                  a detection unit including a synchronous demodulator, said synchronous  
16 demodulator demodulates an output from said pair of charging amplifiers or current

17       amplifiers in synchronous with a driving signal from said drive unit and outputs an  
18       angular velocity signal; and

19               an adjusting unit for adjusting an electrostatic coupling signal generated  
20       in an area around the vibrating part and detection part of said sensor element by  
21       coupling a driving signal from said drive unit to a circuit, said circuit having an output  
22       coupled to said synchronous demodulator.

1               30. An angular velocity sensor as recited in claim 29, wherein said  
2       adjusting unit comprises an attenuator for adjusting a signal synchronized with said  
3       driving signal, and a capacitor for coupling an output signal from said attenuator to a  
4       circuit, said circuit having an output coupled to said synchronous demodulator.

1               31. An angular velocity sensor as recited in claim 29, wherein said  
2       control unit comprises a switch disposed in a loop of said drive unit.

1               32. An angular velocity sensor as recited in claim 29, wherein frequency  
2       of said adjusting signal from said signal generator differs from the frequency of  
3       characteristic vibration mode of said sensor element.

1               33. An angular velocity sensor as recited in claim 30, wherein said  
2       capacitor is integrated in a semiconductor integrated circuit, said integrated circuit  
3       comprises said drive unit and detection unit.

1               34. An angular velocity sensor as recited in claim 30, wherein said  
2       attenuator is capable of adjusting a level of attenuation.

1               35. An angular velocity sensor as recited in claim 30, wherein said  
2       attenuator comprises an amplifier having variable gain.

1                   36. An angular velocity sensor as recited in claim 30, wherein said  
2 attenuator comprises a phase shifter having variable phase shift.

1                   37. An angular velocity sensor as recited in claim 30, wherein said  
2 attenuator includes a digital adjusting unit, said digital adjusting unit is capable of  
3 adjusting the level of attenuation stepwise based on a predetermined digital data.

1                   38. An angular velocity sensor as recited in claim 6, further including a  
2 balancing unit, wherein said balancing unit is disposed at an input terminal of one of  
3 said pair of charging amplifiers or current amplifiers and said input terminal is not  
4 connected to said injector, in order to keep a balance of input characteristics  
5 between each of said pair of charging amplifiers or current amplifiers.

1                   39. An angular velocity sensor as recited in claim 29, wherein said  
2 driver circuit includes a generation unit to generate a pair of signals for driving said  
3 sensor element, the phases of said pair of signals are inverse to each other, and  
4 wherein said sensor includes a selector for selecting either of said pair of signals and  
5 supplying it to said adjusting unit.

1                   40. An angular velocity sensor as recited in claim 29, further including a  
2 selector, said selector selects either of said driving signal or monitor signal whereby  
3 the selected signal is supplied to said adjusting unit.

1                   41. An angular velocity sensor comprising:  
2                   a sensor element including a driver part and a detector part;  
3                   a drive unit for supplying a driving signal to the driver part of said  
4 sensor element; and

5                   a synchronous demodulator, wherein said synchronous demodulator  
6   detects an output from said detector part of said sensor element in synchronous with  
7   the driving signal from said drive unit, and outputs an angular velocity signal.

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9                  42. An angular velocity sensor of claim 41, further comprising:

10                 a self diagnosis unit for outputting a diagnosis signal to detect an  
11   abnormality of said sensor element by coupling a signal synchronized with said  
12   driving signal to a circuit, said circuit having an output coupled to said synchronous  
13   demodulator.